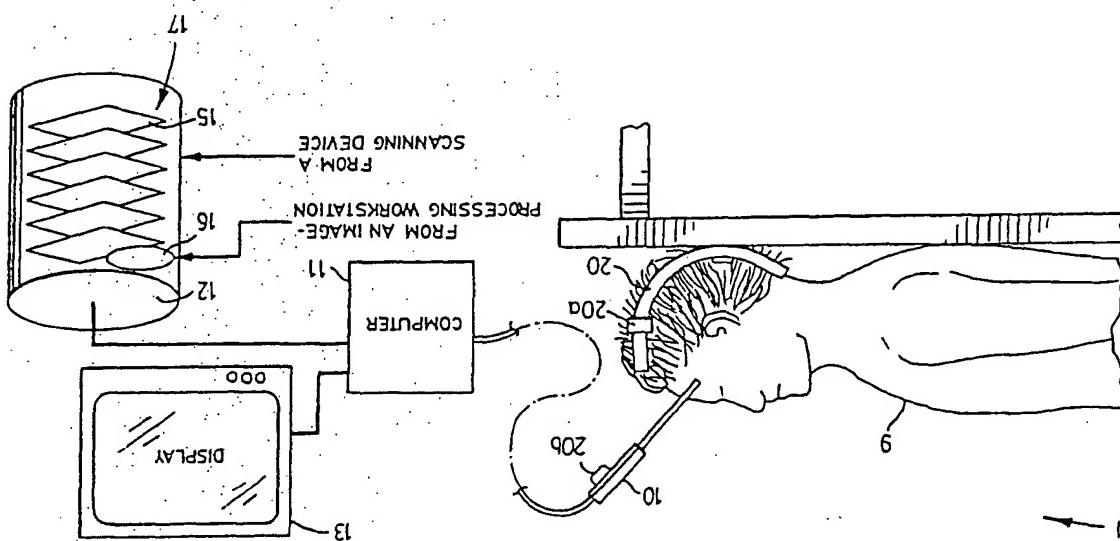


(57) Abstract



(54) Title: PROBE-CORRELATED VIEWING OF ANATOMICAL IMAGE DATA

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 (74) Agent: ROGERS, BERESKIN & PARTRIDGE, 40 King Street West, 40th Floor, Toronto, Ontario M5H 3Y2 (CA).
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(71) Applicant: I.S.G. TECHNOLOGIES INC. [CA/CAY]; 3030 Orlando Drive, Mississauga, Ontario L4V 1S8 (CA).
 (72) Inventors: GREENBERG, Michael, M.; 34 Kew Gardens, Richmond Hill, Ontario L4B 1R5 (CA); DEKEL, Doron; RICHMOND HILL, ONTARIO L4B 1R5 (CA); ZINREICH, Simon; 50 Robert Hicks Drive, Willowdale, Ontario M5R 2R3 (CA); WINSTON, N.; ROSEN, S.; SE, S.; ELOPEAN PATENTS (CA); SN MILLS, MD 21217 (US); RODERICK, ROBERT, N.; 212B STATION MALL, BALTIMORE, MD 21200 (US).
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A computerized system for viewing of internal anatomical regions of a patient based on previously acquired image data of the patient. The anatomical regions are viewed in direct relationship to a moving probe which can be hand-held. The location of the probe relative to the patient is reported to computer. The computer then uses the previously acquired data to generate a detailed view of the patient's anatomy in relationship to the position or orientation of the probe. An operator is able to visualize normally invisible anatomical features before commencing, and during, procedure. The correspondence between positions of the probe relative to the patient's anatomy is determined from the position of the probe in relation to the previously acquired image data of the patient. The anatomical regions are viewed using a probe which can be hand-held. The location of the probe relative to the patient is reported to computer. The computer then uses the previously acquired data to generate a detailed view of the patient's anatomy in relationship to the position or orientation of the probe. An operator is able to visualize normally invisible anatomical features before commencing, and during, procedure. The correspondence between positions of the probe relative to the patient's anatomy is determined from the position of the probe in relation to the previously acquired image data of the patient. The anatomical regions may be employed during diagnostic, therapeutic, or surgical procedures.



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WO 91/07726
Title: Probe-correlated viewing of anatomical image data
FIELD OF THE INVENTION
The invention relates generally to visualizing anatomical images. More specifically, the invention relates to a method and apparatus for determining the position of a probe relative to various anatomical features and displaying the internal anatomical structures for relative to the position of the probe.
5
relates to a method and apparatus for determining the position of a probe relative to various anatomical features for determining the position of the probe.
In recent years it has become commonplace for a surgeon to utilize slice images of a patient's internal organs. The images are used to plan the course of a medical procedure, be it diagnostic, therapeutic, or surgical, and for orientation during the procedure. The images may also be captured using Angiography, Single Photon Emission Computed Tomography, and Position Emission Tomography (SPECT) or by Magnetic Resonance Imaging (MRI).
10
The images are typically generated by Computerized Tomography (CT) or by Magnetic Resonance Imaging (MRI).
Images may also be captured using Angiography. Single
slice images are typically generated by Computerized
tomography, and for orientation during the procedure. The
very detailed and can resolve anatomical structures less
than one millimetre in size. However, their format
differs greatly from the actual anatomical features seen
in two-dimensional form rather than in the three-
dimensional form of the anatomical features. In addition,
the perspective of the slice image rarely corresponds to
the surgical view required to obtain a user const-
20
tomyraphy methods.
The images typically presented to a user consist
of a series of static images on film. These images are
very detailed and can resolve anatomical structures less
than one millimetre in size. However, their format
differs greatly from the actual anatomical features seen
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the perspective of the slice image rarely corresponds to
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tomyraphy methods.
Consequently, during a procedure, the user must constantly switch between the two-dimensional image and the three-dimensional view to correctly orient the probe. This is time consuming and can lead to errors in the procedure.
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35
these larger incisions may result in longer hospital stays
providing an enlarged window to the patient's anatomy, while
the minimum required for the planned procedure. While
body, surgeons can make an incision which is larger than
to obtain proper orientation within a patient's
a primitive visualization aid to the patient's anatomy.
Subsequently, during a procedure, the slice images provide
the surgeon's visualizing the procedure. The procedure
perspective of the slice image rarely corresponds to
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45
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BACKGROUND OF THE INVENTION

The invention relates generally to the position of the probe.
More specifically, the invention relates to a method and apparatus for determining the position of a probe relative to various anatomical features for determining the position of the probe.
5
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tomyraphy methods.

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surgery requires the use of a cumbersome and uncomfortable which have a direct approach path. Secondly, stereotactic firstly, it is only suitable for localized brain lesions stereotactic surgery has a number of drawbacks.

20 automatically. cutting operations, which are done either manually or patient's head. The frame is used to direct drilling and frame is again attached to the same location on the computer. During the surgical procedure, a reference is scanned by the frame, the location of the lesion is 15 located during scanning. Using the marks left in the head during the scanning, the reference frame is rigidly attached to the patient's head during the procedure. It involves method is known as stereotactic surgery. The innovation surgery is currently being used for brain lesions. The

110 known approach to localizing anatomy during a prolonged period. A known as current x-ray tomography scan for to expose a patient to a computerized tomography scan for tissue and cause cancer. It is, therefore, not desirable to sizes x-ray radiation which is known to damage human instruments. Computerized tomography, on the other hand, high fixed magnetic field which produces a very procedures. Magnetic resonance imaging produces a very effects which may harm the patient and inhibit the resonance. Imaging and computerized tomography have side placed in a scanning device. Furthermore, magnetic placed in a scanning device. Secondly, magnetic resonance have limited access to a patient who is maintained during imaging equipment are prohibitive. 10 procedure. First, the costs of purchasing room during to use the equipment in the operating room during the on-the-spot visualization of a patient, it is impractical while imaging equipment can be used to provide

risk to the patient. And recommendation the procedure, or to continue at a high the surgeon may become disoriented forcing him to correct available to the surgeon is greatly limited. As a result, if only a small incision is made, the field of view and increased risk for the patient. On the other hand,

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30 method for visualizing internal regions of an anatomical body in a first aspect; the invention provides a
35 relative to the anatomical body;
(a) obtaining a spatial position for the probe
40 previously acquiring images of the anatomical body, the
body in relation to a probe, employing a data-base of
method for visualizing internal regions of an anatomical body in a first aspect; the invention provides a
45 relative to the anatomical body;
(b) determining a data-base location relative to
50 the anatomical body;

SUMMARY OF THE INVENTION

55 locating the position of a probe;
a application is mainly concerned with an arm structure for
disclosed in an internal application filed by George
resonance imaging scan. An example of such a system is
generated by the computerized tomography or magnetic
60 limited in that they can display only the slice images are
20 displayed on the display capabilities of such systems are
previousiy acquired scan images.
the location of the probe as calculated above on the
(c) a means of displaying the superpositioning of
reference points on the patient; and
15 the position of the probe relative to certain
(b) a computer processing unit which calculates
(a) a multi-jointed probe or sensor arm;

methods use systems comprising:
in conventional open neurosurgery. In general, these
10 tomography or magnetic resonance imaging scans as an aide
designed to allow the use of previousiy acquired Computer
known in the art are systems and methods
is exposed to another dose of radiation.
utilizes computerized tomography imaging, then the patient
5 prolonged and expensive procedure. Moreover, if the scan
second scan with the frame attached. This results in a
first scanning procedure, the patient must undergo a
undertake stereotactic surgery is usually done after a
reference frame. Furthermore, since the decision to
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probe-correlated imaging system;
Figure 3 is a portion of a third embodiment of a
probe-correlated imaging system;
Figure 2 is a portion of a second embodiment of a
correlated imaging system;
Figure 1 is a first embodiment of a probe-
embodiments of the present invention, and in which:
to the accompanying drawings which show, for example,
into effect, reference will now be made by way of example
invention, and to show more clearly how it may be carried
invention, for a better understanding of the present

25 BRIEF DESCRIPTION OF THE DRAWINGS

(e) a display unit for displaying the
representation of the anatomical body.
20 images to generate a representation of a region of the
anatomical body adjacent to the spatial position of the
probe; and
(d) a computer using the previously acquired
body;
spatial position of the probe relative to the anatomical
(c) a spatial determinator for determining the
15 previously acquired images of the anatomical body;
(b) a data-base storage unit containing the
(a) a probe;
images of the anatomical body, the system comprising:
body by utilizing a data-base body of previously acquired
system for visualizing internal regions of an anatomical
In a second aspect the invention provides a
adjacent the data-base location of the probe.
(d) displaying a region of the data-base body
and
base location of the probe relative to the data-base
relative to the anatomical body to the corresponding data-
(c) mapping the spatial position of the probe
of the probe relative to the anatomical body;

the data-base body corresponding to the spatial position
of the data-base body, corresponding to the spatial position
of the probe relative to the anatomical body;

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shown, to point to a particular location on the anatomical base body (17). The probe (10), or any other object which system places the pre-processed images (16) in the data-the anatomical structure of the patient (9). The known according to the relative spatial relationship within (15) and generate pre-processed digital spatial images (16) known systems, not shown, which can read digital images known organs surfaces of the patient (9). There are spatial relationships can be pre-processed to represent the digital spatial images (15) together with their relative contained pre-processed digital images (16). For example, by medical imaging techniques, the data-base body (17) can in addition to the digital images (15) captured Resonance Imaging, Ultrasound, or Angiography.

Tomography, Position Emission Tomography, Magnetic Computerized Tomography, Single-Photon Emission Computed through various medical imaging techniques, such as of the patient (9). These images (15) can be acquired body (17) includes previously acquired digital images (15) anatomical structure of the patient (9). The data-base (12) which contains a data-base body (17) representing the unit the computer (11) has ready access to the unit adjacent to the position of the probe (10).

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 6 is a third display format employed in the system of fig. 1; and the system of fig. 1; and figure 5 is a second display format employed in the system of fig. 1; and figure 4 is a first display format employed in the system of fig. 1.

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(9) body of the patient (9). The operator can move the probe around or within the anatomical body of the patient (10) around or within the anatomical body of the patient (10) to obtain some stable platform nearby, not shown. There are a number of alternative methods which can be used to obtain the spatial coordinates of the probe (10) to its reference point (20). The apparatuses relative to its reference point (20). The probe (10) is positioned at the reference point (20) and a sensor (20a) to receive signals picked up by the sensor emitter (20b), the position and orientation of the probe (10) between the reference point (20) can be determined. A probe (10) using this known location method is complementary available. Given the spatial relationship computer (11) can determine the position of the probe (10) relative to the patient (9). The probe (10) is connected to a multi-joint light-weight arm (25) with a first section (26) and a second section (27) connected together at joint (22). The first section (26) of the multi-joint arm (25) is connected to a base (28) at joint (28) is attached to the patient (9) using (21). The base (28) is connected to a multi-joint arm (25) is connected to the probe (10) it is attached to the probe (10) is attached to the second section (27) at joint (24). The probe (10) is moved along the second section (27) at joint (24) to the second section (27) at joint (24). The probe (10) is moved along the second section (27) at joint (24) to the second section (27) at joint (24).

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The angular sensors are connected by wire (28a) to one another and to an electronic unit (29). The sensors detect any change in the position or orientation of the multi-joint arm (25), and convey this information

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readily identifiable features of the patient, such as the small markers, usually made of card or ceramic material, on procedure is performed. Another method involves placing images (15) were generated and the time the surgical images (9) may be erased between the time the scan on the patient. (9) is a risk that the marked positions to convenient and there is a risk that this can be points on the patient. (9). However, this can be example, one method involves the marking of reference 30 number of registration methods are known. For

(17) with the computer (11).

anatomical body of the patient (9) and the data-base body purpose is to register the correspondence between the 25 (17). This procedure is known as "registration" since its procedure which maps the patient (9) to the data-base body correspondence, may be initially determined through a corresponding adjacent data-base body (17) location. This current spatial position of the probe (10) and the 20 this sense mapping is a procedure for determining the locations in data-base body (17) during the procedure. In positions of the anatomical body of the patient (9) to the probe (10), the system (1) must be able to map registration of the anatomical body of the patient (9) adjacent processed image (16), which correctly corresponds to the 15 processed image (15) or pre-to display the data-base image (15) or pre-

a new spatial relationship must be established.

moved during the procedure, a new reference point (40) or 10 determined, therefore, if the patient (9) is 40) to the registration of the probe (10) to the relative joint (41) may be determined once and the relative 15 reference position of the reference point (40) to the reference point (40) can be fixed arbitrarily in space.

straps (49). If the patient (9) is fixed, then the 5 (48). The patient can be fixed to an operating table omitted if the patient (9) is fixed to an operating table (48) using (47).

to the computer (11) of fig. 1 via the communication link

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The method is as follows. The probe (10) is placed next to the feature point on the patient (9). The spatial position of the probe (10) is then determined. A movable marker, e.g., a cursor, on the display (13) is then adjusted so it coincides with a selected feature, e.g., a corner of the eyes (70) as seen. It is then simple for the computer (11) to perform necessary three dimensional transformation, so that the spatial position of the probe (10) and the corresponding body location are registered with the computer (11). Using a set of at least three, and preferably about six, feature points on the patient, a proper and unique transformation function, can be calculated which maps the spatial points of the probe (10) to the corresponding data-base points of the probe (10) to the correct accuracy of this body location and orientation. The transformation function is improved by the use of a larger number of points and a statistical error minimization techniques, such as the least mean square error method.

Once the anatomical body of the patient (9) has been registered with the computer (11), the operator can

The preferred registration method involves using the probe (10) to register with the computer (11) the spatial position of easily identifiable features of the patient, such as the space between the teeth, the nose or the corners of the eyes. In this method, the previously acquired scan images (15) or the pre-processed images (16) are displayed on the display (13). It such a manner as to allow the user of the system (1) to identify specific points of the chosen features of the patient (9). A three dimensional surface format, shown in figure 6, is the simplest such format for an unskilled viewer to comprehend. Such a three-dimensional surface format can be derived from the pre-processed images (16) in a known manner, and suitable points such as the corners of the eyes (70), space between the teeth (72) are shown in figure 6.

ears or the corners of the eyes.

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orientation of the probe (10). It is not strictly necessary to use the orientation of the display (13) to carry out many of the features represented on the display (13) as a point rather than a full probe (10). The region adjacent to the point probe (10) may be known from the computer (11) and not displayed as is then displayed. The orientation of the regions is determined by the orientation of the probe (10). A possible presentation format for the data-base images (15) of the patient (9) is shown in fig. 4. Two-dimensional representations or slice images are generated by the computer (11) from the data-base images (15). The position of the probe (10) relative to the anatomical body (9) is marked on a slice image (50) by the computer (11). The slice image (50) is displayed on the unit (13). The separate windows (25) into which the screen of the display unit (13) is divided are displayed on the unit (13).

The separate windows (25) into which the screen of the display unit (13) is divided contain three windows containing three-dimensional representations of the probe (10) relative to the patient (9). The anatomical features of the patient (9) are observed to the right and left. The position of the probe (10) in the patient (9) relative to the anatomical features of the patient (9) can be observed at the display unit (13) can show a slice (57) through the anatomical features in mid-sagittal orientation along the axis of the probe (10). The four thoracic windows depicted on the display unit (13) can anterior, posterior, superior, inferior, right and left. The sagittal orientation along the axis of the probe (10) can show a slice (57) through the anatomical features in mid-sagittal orientation along the axis of the probe (10) in the position of the probe (10) in the patient (9). Relative to the anatomical features of the patient (9), the operator can observe the three slices (50, 54, 56) intersecting at the location of the probe (52). Thus, the three cardinal anatomical planes: sagittal (50); axial (54); and coronal (56). The three slices correspond to three cardinal anatomical planes: sagittal (50); axial (54); and coronal (56).

move the probe (10) in and around the patient (9), and at the same time view the hidden anatomical features of the patient (9) as they appear in the data-base body (17). The same time view the hidden anatomical features of the patient (9) as they appear in the data-base body (17). In the base body (17) are presented on the display unit (13) in the spatial position and possibly related to the spatial position of the probe (10).

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Another presentation format for the data-base images (15) and pre-processed images (16) is shown in FIG. 5. A three-dimensional model (58) of the patient (9) is generated by the computer (11) from the images (15). The computer (11) also generates a three-dimensional model (60) of the probe (10). The relative locations of the patient (9) and orientation of the probe (10) correspond to the spatial position of the models (60), (58) of the probe (10). The direct viewing of what lies ahead of the probe (10) together with the model (60) on the display unit (13).

Other display methods than the display of slices or using pre-processing may be used in conjunction with the principles described herein. For example, the computer (11) can generate displays directly from the computer (11) using a ray-cast method. In one ray-cast images (15) using a ray-cast method. In another ray-cast method a simulated x-ray display. In another ray-cast method a simulated x-ray display along with the x-rays. The results may be displayed along with the x-rays. The results may be displayed through the images (15). The elements in the rays passing through the images (15) do not pass the surface features and may be used to generate rays corresponding to surface features which do not pass the simulated light rays images (15). Which do not pass the simulated light rays images (15). The elements in the simulated display is created using the results of simulated light rays passing through the simulated display to the computer (11). The computer (11) generates simulated rays corresponding to those described for slices or 3d-images. This produces to those described for slices or 3d-images. This produces a simulated x-ray display. In another ray-cast method a simulated x-ray display to the computer (11). The computer (11) generates simulated rays corresponding to the simulated rays. The results may be displayed through the simulated rays.

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1. A method for visualizing internal regions of an anatomical body in relation to a probe, employing a data-base body of previously acquired images of the anatomical body, comprising steps of:
 - (a) determining a data-base location relative to the anatomical body for the probe;
 - (b) obtaining a spatial position for the probe relative to the anatomical body;
 - (c) mapping the spatial position of the probe relative to the anatomical body;
 - (d) displaying a region of the data-base body adjacent to the data-base location of the probe, the region being derived from a plurality of adjacent images of the data-base body;
2. A method as recited in claim 1, wherein displaying a region of the data-base body adjacent to the data-base location of the probe, the region being derived from a plurality of adjacent images of the data-base body, comprises steps of:
 - (a) generating a slice image from the previousl
 - (b) displaying the slice image adjacent to a data-base location of the probe; and
 - (c) displaying a region of the data-base body adjacent to the data-base location of the probe, the region being derived from a plurality of adjacent images of the data-base body.
3. A method as recited in claim 1, wherein displaying a region of the data-base body adjacent to the data-base location of the probe, the region being derived from a plurality of adjacent images of the data-base body, comprises steps of:
 - (a) generating a three-dimensional body model adjacent to the data-base location of the probe;
 - (b) displaying a region of the data-base body adjacent to the data-base location of the probe;
 - (c) displaying a region of the data-base body adjacent to the data-base location of the probe, the region being derived from a plurality of adjacent images of the data-base body.

WE CLAIM:

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- WO 91/07726 DRAFT
PCT/CN/00404
9. A method as recited in claim 1, 2 or 3 wherein the spatial orientation of the probe is obtained along with its spatial position.
10. A method as recited in claim 1, 2 or 3 wherein a representation of the probe is displayed along with the registration of the data base body adjacent to the data-base location of the probe and the relative locations of the probe and the probe and data-base base relative to the probe.
11. A method as claimed in claim 5, wherein a representation of the probe corresponds closely to the three-dimensional body model, the relative location of the probe is displayed with the three-dimensional body model, the probe is oriented to the three-dimensional body model, and wherein the representation of the probe corresponds to the probe relative to the actual probe, and wherein the representation of the probe is added to the probe presentation of the probe.
12. A method as claimed in claim 11, wherein the representation of the probe corresponds closely to the probe relative to the probe presentation of the probe.
13. A method as recited in claim 1, further including the steps of: obtaining the spatial position, registration prior to a particular feature of the anatomical body; (a) positioning the probe next to a particular feature of the anatomical body;

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- WO 91/07726
PCT/CN90/00404
15. A method as recited in claim 1, further including the steps of:
(a) marking a position on the anatomical body of a particular scanned image containing a corresponding position in the database body;
(b) positioning the probe next to the marked location in the database body;
(c) determining the spatial position of the probe corresponding to particular features of the anatomical body;
(d) registering the spatial position of the probe and its corresponding database body location, whereby, a database body location is determined to correspond to particular features of the anatomical body which comprises a step for registration prior to obtaining the spatial position of the probe;
(e) registering the spatial position of the probe and the location on the data-base body corresponding to the probe position, whereby, a database location is determined to correspond with a spatial position of the probe.
14. A method as recited in claim 1, further including the steps of:
(a) marking locations in the data-base body which corresponds to particular features of the anatomical body;
(b) positioning the probe next to a particular feature of the anatomical body;
(c) displaying a region of the particular feature on the probe; and
(d) identifying the particular feature having a data-base body corresponding to the displayed region; and
(e) registering the spatial position of the probe and the location on the data-base body corresponding to the probe position, whereby, a database location is determined to correspond with a spatial position of the probe.

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A method as claimed in claim 19, wherein the probe is connected to the anatomical body by one of (a) a multi-joint arm and a base for securing to the anatomical body with the arm connecting the base to the probe and (b) a stand, a pair of multi-joint arms, one of which connects the probe to the stand and the other of which

20.

body is maintained.

A method as claimed in claim 13, wherein the probe is connected to the anatomic body in such a manner that, following registration, if the anatomic body is displaced, registration between the data-base body and the anatomic body is disrupted, registration being automatical.

• 61

A method as claimed in claim 13 or 16, wherein more than three data-base locations are identified and wherein errors between the data-base locations are corrected according to base-locations and positions are minimized to improve the accuracy of the registration step.

• 17

A method as claimed in claim 13, wherein the display of step (c) is a three-dimensional display.

• 16

(c) determining the spatial position of the probe;

(d) registering the spatial position of the probe and its corresponding data-base body location,

whereby, a data-base body location is determined to correspond with a spatial position of the probe.

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21. A system for visualizing internal regions of an anatomical body by utilizing a data-base body of previous-ly acquired images of the anatomical body; a probe; a data-base storage unit containing the spatial position of the probe relative to the anatomical body; a computer using the previous-ly acquired images of the anatomical body to generate a representation of the spatial position of the probe; and a display unit for displaying the representation of the anatomical body.

(a) a probe;

(b) a data-base storage unit containing the spatial position of the probe relative to the anatomical body;

(c) a spatial determinant for determining the images to generate a representation of a region of the anatomical body adjacent to the spatial position of the probe; and

(d) a computer using the previous-ly acquired images to generate a representation of the spatial position of the probe relative to the anatomical body.

22. A system as recited in claim 21, wherein the representation of the anatomical body is three-dimensional surface format.

23. A system as recited in claim 21, wherein the probe is adapted to be initialized for the computer in the location in the data-base storage unit corresponding to the spatial position of the probe by having the data-base body having a particular feature, having identified the particular feature on the display of the data-base body having a region a point of the data-base body having a particular position of the spatial position of the probe, determining a particular feature point of the anatomical body, determining the spatial position of the probe corresponding to the spatial position of the probe by the particular feature, and displaying a particular feature of the data-base body having a region a point of the data-base body having a particular position of the spatial position of the probe.

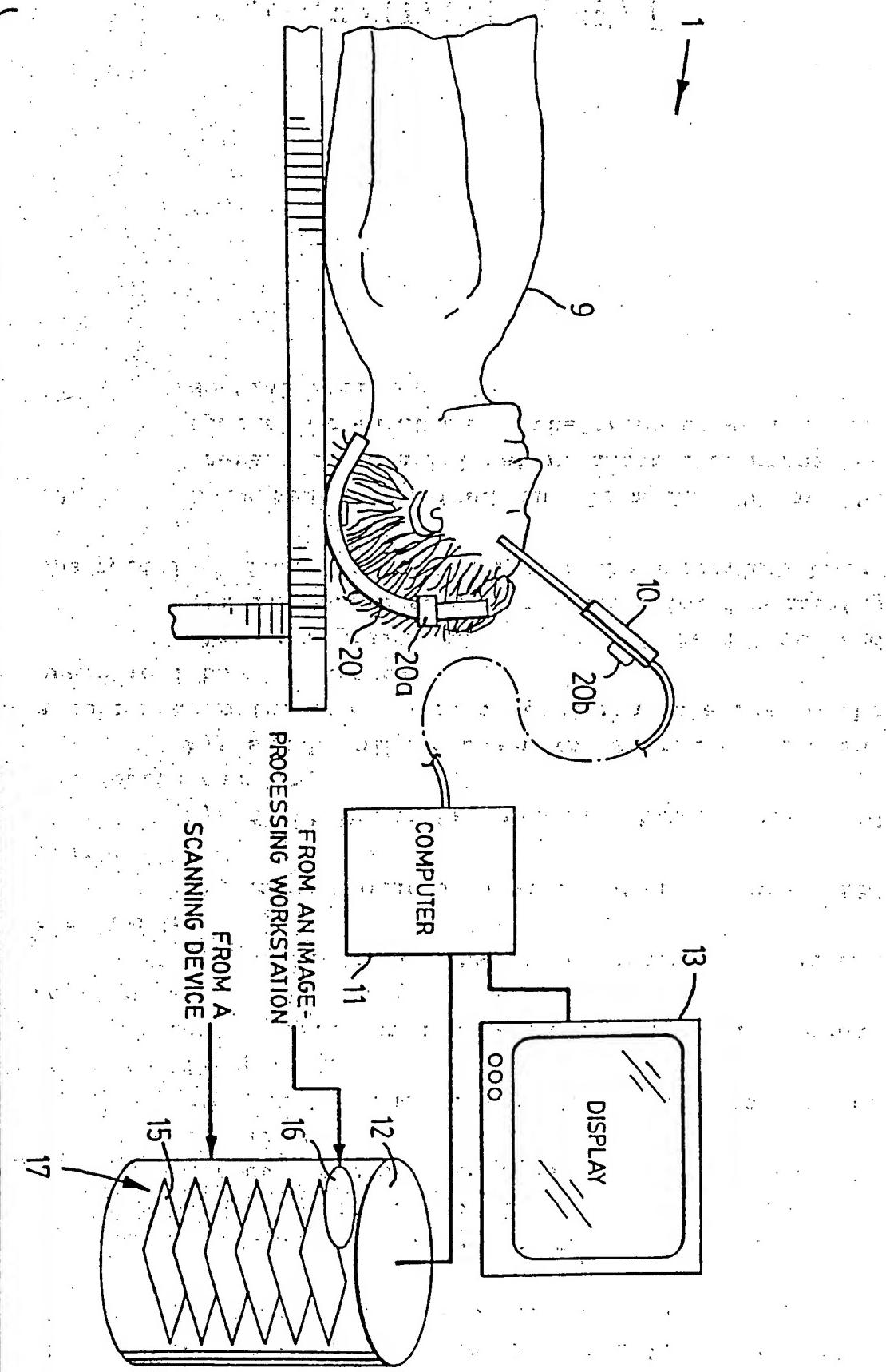
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24. A system as recited in claim 23, wherein the generated images are displayed in 3-dimensional format during registration, and the particular features are identified on the three-dimensional features corresponding to the position of the particular feature.
25. A system as recited in claim 21, wherein the spatial determinator includes:
(a) an electro-magnetic emitter on a reference point for transmitting a signal;
(b) a sensor on the probe for receiving the signal; and
(c) means for comparing the transmitted signal with the received signal to determine the position of the probe.
26. A system as recited in claim 21, wherein the spatial determinator includes:
(a) a first section connected between first and second joints, the first joint being connected to the anatomical body at a known point whose spatial relation to the anatomical body is relative to the first joint fixed to a reference second joint; and a third joint, the third joint being connected to the probe to the first, second and third sensors positioned at the first, second and third joints; and
(b) a second section connected between the first and a third joint, the third joint being connected to the probe; and
(c) first, second and third sensors positioned at the first, second and third joints connected to the probe.
27. A system as recited in claim 26, wherein the third sensors for determining the position of the probe (d) means connected to the first, second and third joints, and the first, second and third sensors relative to the anatomical body.
- A system as recited in claim 26, wherein the third sensors are angular first, second and third sensors.

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28. A system as recited in claim 27, wherein the reference point is on the anatomical body.
29. A system as recited in claim 21, wherein the spatial determinant includes:
- a) first, second, third and fourth sections;
- b) a stand;
- c) a first joint between the first section and
- d) a second joint between the first and second sections;
- e) a third joint between the second section and
- f) a fourth joint between the stand and the third section;
- g) a fifth joint between the third section and
- the fourth section;
- h) a sixth joint between the fourth section and
- a reference point whose spatial position relative to the anatomical body is known;
- j) means connected to the sensors for determining the position of the probe relative to the anatomical body.
30. A system as recited in claim 21, 26 or 29,
- wherein the spatial orientation of the probe as well as its spatial position.

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FIG.3

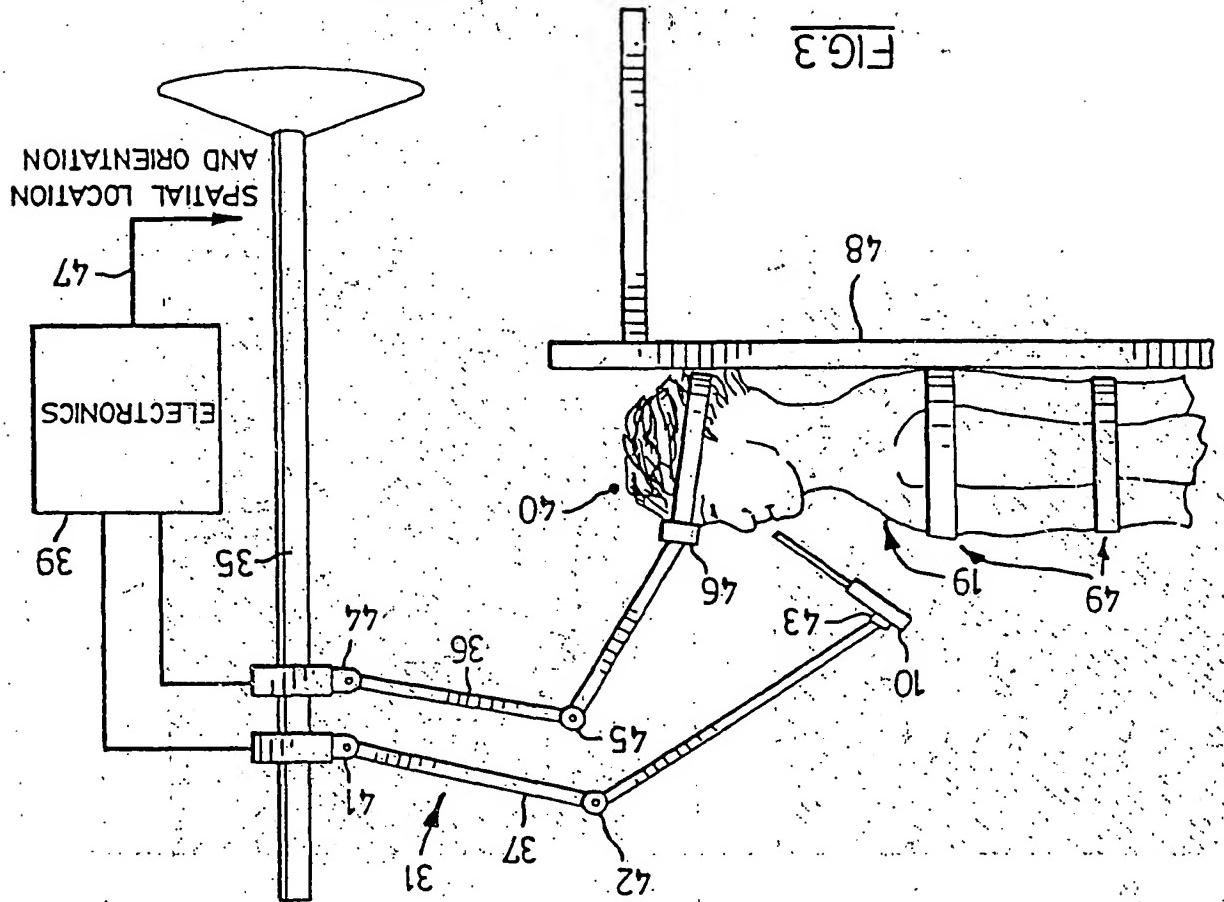
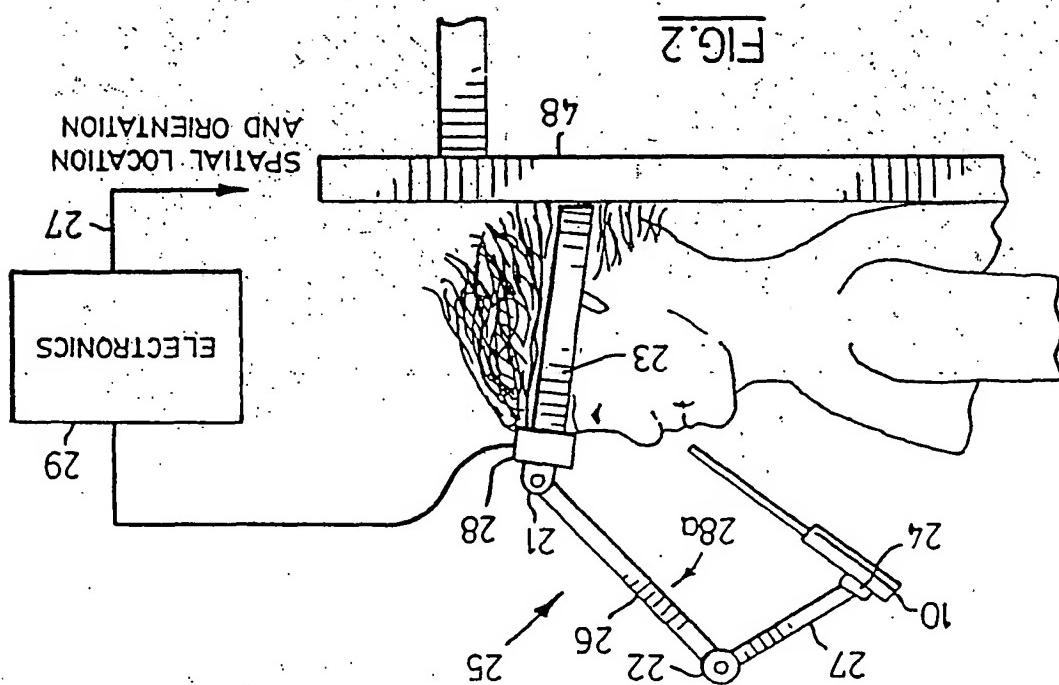


FIG.2



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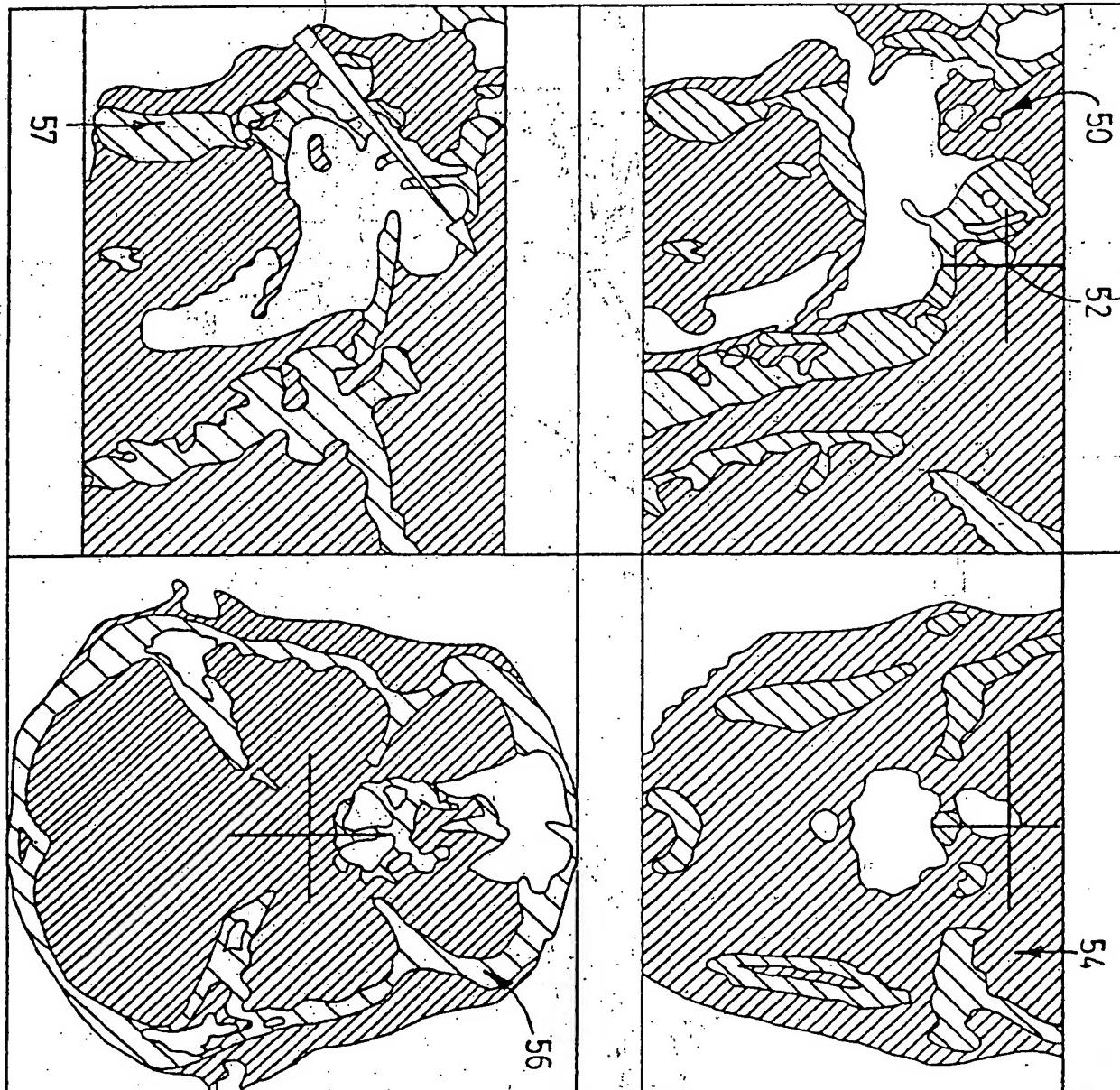


FIG. 4

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FIG. 6

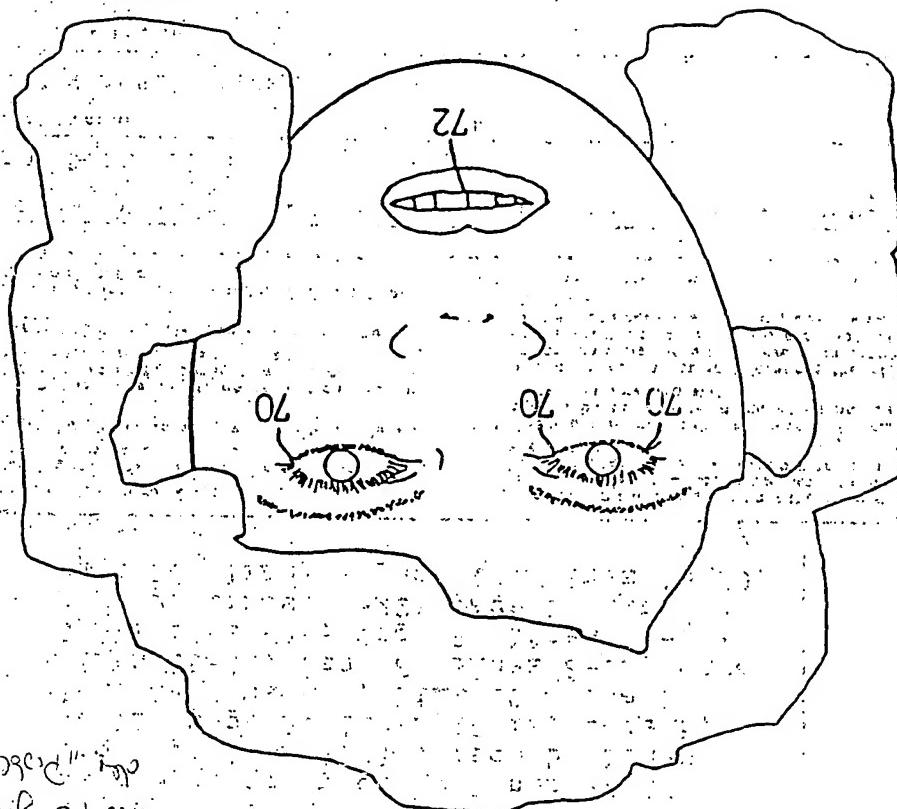
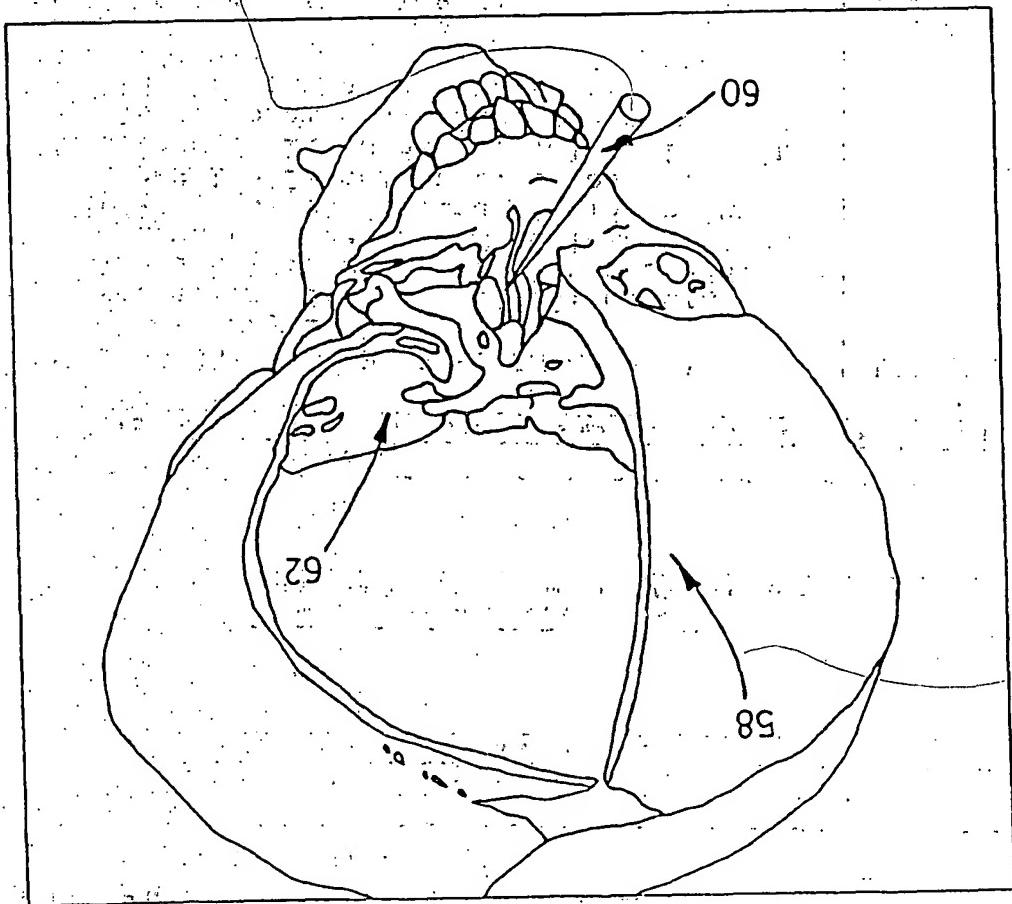


FIG. 5



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INTERNATIONAL SEARCH REPORT	
International Application No. PCT/CA 90/00404	
IPC 5: G 06 F 15/72, A 61 B 5/11	
<p>According to International Patent Classification (IPC) or to both National Classification and IPC.</p> <p>I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all)</p>	
<p>Classification System Minimum Documentation Searched Classification Symbols</p>	
<p>II. FIELDS SEARCHED</p>	
<p>IPC 5 G 06 F 15/72</p>	
<p>To the Extent that such Documents are included in the Fields Searched</p> <p>Documentation Searched other than Minimum Documentation</p>	
<p>III. DOCUMENTS CONSIDERED TO BE RELEVANT</p>	
<p>X US, A, 4638798, (C.H. SHELDEN et al.) 1-19, 21-24</p>	
<p>Citation of Document(s) with Indication, where appropriate, of the relevant passages is relevant to Claim No. 13</p>	
<p>Category Citation of Document(s) with Indication, where appropriate, of the relevant passages is relevant to Claim No. 13</p>	
<p>P,X WO, A, 9005494 (C. GIORGIO) 1-30</p>	
<p>see abstract; page 1, lines 22-26, page 4, lines 27-30; page 5, lines 10-11; page 5, lines 18-19; page 5, line 23; - page 6, line 10; page 5, lines 16-24; page 8, lines 8-15; page 8, lines 25-28; page 9, lines 10-14; lines 16-24; page 10, lines 1-5-20; page 9, lines 17-22; page 9, lines 23 - page 10, lines 1-5-20, lines 1-5-20;</p>	
<p>• Special categories of cited documents: 19 "A" document defining the general state of the art which is not considered to be of particular relevance or which is not considered to be of particular relevance or which is not considered to be of particular relevance or which is not considered to be of particular relevance or which is not considered to be of particular relevance.</p>	
<p>IV. CERTIFICATION</p>	
<p>Date of the Actual Completion of the International Search 7th March 1991</p>	
<p>Signature of Authorized Officer</p>	
<p>EUROPEAN PATENT OFFICE</p>	

Category	Claim(s) of Document, with indication, where appropriate, of the relevant passages.	Relevant to Claim No.
III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)	Page 10, Lines 29-30; Page 11, Lines 26-30; Page 12, Lines 5-9; Page 12, Lines 24-29.	

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4638798	27-01-87	None	
WO-A- 9005494	31-05-90	EP-A- 0406352	09-01-91

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EPO file on 08/04/91. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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ANNEX TO THE INTERNATIONAL SEARCH REPORT
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